APPENDIX C
LABORATORY DATA

SOIL FOODWEB INC.
ENERGY LABS
SERVI-TECH LABS
MSU SOIL LAB

Emailed 8-6-2001

Kendall

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Corvallis, OR 97330
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Soil and Compost Foodweb Analysis

Client: Richard Prodgers
Bighorn Environmental
305 W. Mercury
Butte, MT 59701

Sample Received: 07/09/2001
Plant: unspecified
Invoice # 3369
Grower:

Date Mailed: August 6, 2001
Equal Bacteria-Fungi

Organism Biomass Data

Sample #	Treatment	Dry Weight of 1 gram Fresh Material	Active Bacterial Biomass (µg/g)	Total Bacterial Biomass (µg/g)	Active Fungal Biomass (µg/g)	Total Fungal Biomass (µg/g)	Hyphal Diameter (µm)	Protozoa Numbers /g			Total Nematode Numbers (#/g)	Percent Mycorrhizal Colonization of Root
								Flagellates	Amoebae	Ciliates		
89679	1994 Horseshoe Pit #1	0.91	NR	**128**	NR	**144**	**2**	**5,065**	**305**	**15**	0.4	NR
89680	1994 N. Face Slope	0.95	NR	192	NR	224	2.5	**3,275**	**376**	**0**	3.9	NR
89681	1999 SE Slope	0.90	NR	**137**	NR	**38**	2.5	**3,064**	**3,064**	**15**	1.3	NR
89682	Reference	0.85	NR	170	NR	774	3	**543**	**543**	54	0.1	NR
89683	Lower Reference	0.86	NR	180	NR	181	2.5	**6,664**	**5,334**	67	5.7	NR
89684	1990 Non-irrigated Wedge	0.90	NR	156	NR	**59**	**2**	**1,533**	**636**	**15**	0.9	NR
Bold means low		Not enough moisture, need to improve water holding capacity by improving soil foodweb and soil strucutre		679 and 681 too low, need bacterial foods		679, 681 and 684 are too low, need fungal foods	679 and 684 are mostly actino-bacteria,not true fungi. actino-bacteria are not highly beneficial to plants	Protozoan numbers too low, plants will be stress availability until the foodweb is improved. Fertilizer can be used short-term, but to retain nutrients in soil, need to improve the foodweb. Typically, addition of good, aerobic compost or compost tea will inoculate the needed protozoa and the foods to feed them.			Low numbers, extremely low diversity, root-feeders, feeders need VAM, beneficial nematodes, fungi to combat	
Desired Range		Field Capacity	10 - 25	150 - 300	10 - 25	150 - 300	(A)	10,000+	10,000+	50 - 100	20 - 30	40%- 80%

(A) Hyphal diameter of 2.0 indicates mostly actinomycete hyphae, 2.5 indicates community is mainly ascomycete, typical soil fungi for grasslands, diameters of 3.0 or higher indicate community is dominated by highly beneficial fungi, a Basidiomycete community.

Season, moisture, soil and organic matter must be considered in determining optimal foodweb structure. If sample information, such as pesticide, fertilizer tillage, irrigation are not included on the submission form, sender's locale is used. One report is sent to the mailing address on the submission form.

Organism Ratios

Sample #	Treatment	Total Fungal to Total Bacterial Biomass	Active to Total Fungal Biomass	Active to Total Bacterial Biomass	Active Fungal to Active Bacterial Biomass	Plant Available N Supply from Predators (lbs/ac)	Root-Feeding Nematode Presence
89679	1994 Horseshoe Pit #1	1.13	NR	NR	NR	< 25	None detected
89680	1994 N. Face Slope	1.16	NR	NR	NR	< 25	None detected
89681	1999 SE Slope	**0.28**	NR	NR	NR	< 25	Spiral, Stunt
89682	Reference	4.55	NR	NR	NR	50 - 60	Stunt
89683	Lower Reference	1.00	NR	NR	NR	50 - 60	Pin, Spiral, Lance, Stunt
89684	1990 Non-irrigated Wedge	**0.38**	NR	NR	NR	< 10	Stunt
		Low if desired plant is grass, too bacterial, need more fungi				Low nutrient cycling, need inoculum of protozoa	Serious root-feeders suggest soil health is very much out-of-balance. Need 'AM, beneficial nematodes, beneficial fungi inoculated into materials
Desired Range		(1)	(2)	(2)	(3)	(4)	(5)

(1) Brassica: 0.2-0.5; Row crops: 0.6 to 1.2; Early successional grass: 0.5-0.75; Late successional grass: 0.8 to 1.5; Berries, shrubs, vines: 2-5; Deciduous Trees: 5-10; Conifer: 10-100.

(2) Warm spring, early summer: 0.25 to 0.95; Early spring, late winter & mid-summer: 0.10 to 0.15; Fall rain: 0.15 to 0.20; Drought/frozen soil/heavy metal/many pesticides: 0.05 or lower. Values greater than indicated mean the organisms are recovering from a negative impact. Values lower mean organisms are not recovering and help is needed, typically addition of their food resource is required.

(3) Generally 1:1 results in good soil aggregate structure in crop soil; 2 to 5 for deciduous trees; 5 for conifers. Values above 1:1 mean soil pH may be decreasing, values less than 1:1 means pH increasing. Anaerobic conditions generally will result in extremely low soil pH.

(4) Based on release of N from protozoan and nematode consumption of bacteria and fungi (see Ingham et al. 1985). Often protozoa and nematodes compete for food resources. When one is high, the other may be low. Also, if predator numbers are high, the prey may have low numbers.

(5) Identification to genus.

NEMATODE NUMBERS PER GRAM FRESH SOIL

	SAMPLE # 89679	89680	89681	89682	89683	89684
BACT-FEEDERS						
CEPHALOBUS	0	0.27	0.25	0.01	0.36	0.03
EUCEPHALOBUS	0	0	0.03	0	0	0
HETEROCEPHALOBUS	0	0	0.63	0.01	0.36	0
TRIPYLA	0	0	0	0	0.07	0.03
CHILOPLACUS	0.03	0	0.03	0	0	0
CERVIDELLUS	0	0	0	0	0.07	0.02
RHABDITIDAE II	0	0	0	0	1.24	0.10
PLECTUS	0.02	0.14	0	0.01	0	0.02
PRISMATOLAIMUS	0	0	0	0	0	0.10
RHABDOLAIMUS	0	0.07	0	0	0	0.14
PROCHROMADORA	0	0	0	0.01	0	0
FUNGAL-FEEDERS						
MICRODORYLAIMUS	0	0.20	0	0.01	0	0.07
EPIDORYLAIMUS	0.01	0	0	0.01	0	0
EUDORYLAIMUS	0.30	0.41	0	0	0.15	0.02
PUNGENTUS	0	0.14	0	0	0	0.02
THONUS	0	0	0	0	0	0.05
THORNIA	0.01	0	0	0	0	0
FUNGAL/ROOT -FEEDERS						
APHELENCHUS	0	0.14	0.08	0	0.15	0
APHELENCHOIDES	0	0.20	0	0	0.15	0.02
BITYLENCHUS	0	0	0	0	0.36	0.02
DITYLENCHUS	0	0.27	0	0	0	0
FILENCHUS	0	0	0.05	0	0.36	0.03
TYLENCHUS	0	1.15	0	0	0	0
MALENCHUS	0.01	0.68	0.03	0	0.58	0.05
ROOT-FEEDERS						
PARATYLENCHUS	0	0	0	0	0.07	0
SCUTYLENCHUS	0	0	0	0	0.07	0
HELICOTYLENCHUS	0	0	0.08	0	0.58	0
MELOIDOGYNE	0	0	0	0	0.15	0
HOPLOLAIMUS	0	0	0	0	0.07	0
TYLENCHORYNCHUS	0	0	0.03	0.01	0.07	0.10
PREDATORY NEMA						
MONONCHUS	0	0	0	0	0	0.02

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LABORATORY ANALYSIS REPORT

Spectrum Engineering	**Project ID:**	**KENDALL MINE TOPSOIL & SUBSOIL**	
William Maehl	**Sample ID:**	**K-1, LEACH PAD 3 TAILING COVER**	
1413 4th Avenue North	**Laboratory ID:**	**01-53441-2**	
Billings, MT 59101	**Sample Matrix:**	**Soil**	
	Sample Date:	**07-May-01 0000**	**Additional Analysis**
	Received at lab:	**08-May-01**	**Reported:** **29-Jun-01**

	Results	Units	Qual	Reporting Limit	Regulatory Limit	Method	Analyzed	
3050 Digestion						EPA 3050B	14-Jun-01 0930	MGS
Arsenic, Total	594	ug/g		5		EPA 3050	21-Jun-01 0013	RLH
Thallium, Total	131	ug/g		5		EPA 3050	21-Jun-01 0013	RLH

As + Tl Stockpile A-7, A-1

Leach Pad #3

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LABORATORY ANALYSIS REPORT

Spectrum Engineering	Project ID:	KENDALL MINE TOPSOIL & SUBSOIL		
William Maehl	Sample ID:	K-10, A-7 SUBSOIL STOCKPILE		
1413 4th Avenue North	Laboratory ID:	01-53441-10		
Billings, MT 59101	Sample Matrix:	Soil		
	Sample Date:	07-May-01 0000		Additional Analysis
	Received at lab:	08-May-01	Reported:	29-Jun-01

	Results	Units	Qual	Reporting Limit	Regulatory Limit	Method	Analyzed	
3050 Digestion						EPA 3050B	14-Jun-01 0930	MGS
Arsenic, Total	430	ug/g		5		EPA 3050	21-Jun-01 0020	RLH
Thallium, Total	130	ug/g		5		EPA 3050	21-Jun-01 0020	RLH

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LABORATORY ANALYSIS REPORT

Spectrum Engineering
William Maehl
1413 4th Avenue North
Billings, MT 59101

Project ID:	**KENDALL MINE TOPSOIL & SUBSOIL**
Sample ID:	**K-7, A-1 SUBSOIL STOCKPILE**
Laboratory ID:	**01-53441-7**
Sample Matrix:	**Soil**
Sample Date:	**07-May-01 0000**
Received at lab:	**08-May-01**

Additional Analysis
Reported: **29-Jun-01**

	Results	Units	Qual	Reporting Limit	Regulatory Limit	Method	Analyzed	
3050 Digestion						EPA 3050B	14-Jun-01 0930	MGS
Arsenic, Total	354	ug/g		5		EPA 3050	21-Jun-01 0016	RLH
Thallium, Total	68	ug/g		5		EPA 3050	21-Jun-01 0016	RLH

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Lab Nos. 01-53441-2, 7, 10

QUALITY ASSURANCE DATA PACKAGE

This report is a summary of the results of the quality assurance tests performed with the sample analyses. They are performed to determine if the methodology is in control and to monitor the laboratory's ability to produce accurate and precise results. The date the quality assurance sample was analyzed is consistent with Energy Laboratories' Quality Assurance Plan.

	Duplicate Analysis --- µg/g (ppm) ---		Spiked Analysis %	Blank Analysis	Calibration Sample Analysis	Acceptance Range
Total Metals [1]	Original	Duplicate	Recovery	µg/g (ppm)	µg/g (ppm)	µg/g (ppm)
Arsenic, Total	41	40	93	<5	40	34.3-69.7
Thallium, Total	39	39	77	<5	51	37.9-97.4

[1] Digestion performed on 06/14/01 using EPA Method 3050B.

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LABORATORY REPORT

TO: William Maehl
ADDRESS: Spectrum Engineering
1413 4th Avenue North
Billings, MT 59101

LAB NO.: 001-012-01-53441
DATE: 06/22/01 rb

SOIL ANALYSIS
Kendall Mine Topsoil & Subsoil
Sampled 05/07/01
Submitted 05/08/01

Sample Number	Identification	pH, s.u. Sat. Paste	Sand %	Silt %	Clay %	Texture	Coarse Fragments %
01-53441-001	K-2	7.7	44	38	18	L	<2
01-53441-002	K-1	7.8	36	45	19	L	<2
01-53441-003	K-3	7.6	45	31	24	L	<2
01-53441-004	K-4	7.7	44	36	20	L	<2
01-53441-005	K-5	7.8	60	21	19	SL	<2
01-53441-006	K-6	7.9	38	36	26	L	<2
01-53441-007	K-7	7.8	43	37	20	L	<2
01-53441-008	K-8	6.8	46	32	22	L	5
01-53441-009	K-9	7.7	46	30	24	L	<2
01-53441-010	K-10	7.7	50	31	19	L	<2
01-53441-011	K-11	7.4	49	32	19	L	<2
01-53441-012	K-12	7.7	N/A	N/A	N/A	N/A	N/A
DUPLICATE ANALYSIS							
01-53441-011	K-11	7.8	47	33	20	L	N/A
CONTROL SOIL	**	6.8	48	32	20	L	N/A
TARGET RANGE	**	(6.4-7.1)	(41-53)	(31-41)	(12-22)	N/A	N/A
DATE ANALYZED	**	06/14/01	05/11/01	05/11/01	05/11/01	05/11/01	05/09/01
BLANK	**	N/A	N/A	N/A	N/A	N/A	N/A
SPIKE, %	**	N/A	N/A	N/A	N/A	N/A	N/A
DET. LIMIT	**	0.1	1	1	1	N/A	N/A
METHOD #	**	ASA Mono #9 Method 10-3.1	ASA Mono #9 Part 1 Method 15-5	ASA Mono #9 Part 1 Method 15-5	ASA Mono #9 Part 1 Method 15-5	ASA Mono #9 Part 1 Method 15-5	ASA Mono #9 Part 1 Method 15-5

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LABORATORY REPORT

TO: William Maehl
ADDRESS: Spectrum Engineering
1413 4th Avenue North
Billings, MT 59101

LAB NO.: 001-012-01-53441
DATE: 06/22/01 rb

SOIL ANALYSIS
Kendall Mine Topsoil & Subsoil
Sampled 05/07/01
Submitted 05/08/01

Sample Number	Identification	Organic Matter %	LOI @ 400C %	Ammonia as N KCL Extract ug/g	Nitrate as N KCL Extract ug/g	Phosphorus(Olsen) NaHCO3 Extract ug/g	Potassium NH4OAc Extract ug/g
01-53441-001	K-2	0.67	1.2	1.2	11.7	4.8	69
01-53441-002	K-1	0.93	1.2	1.1	75.4	8.3	65
01-53441-003	K-3	2.85	3.6	1.1	3.3	23.7	174
01-53441-004	K-4	0.24	0.7	<1	23.0	2.4	58
01-53441-005	K-5	0.21	0.5	<1	7.1	3.6	61
01-53441-006	K-6	1.16	2.0	<1	2.2	12.8	127
01-53441-007	K-7	0.55	1.7	<1	<1	4.5	51
01-53441-008	K-8	2.21	3.6	2.1	<1	14.0	144
01-53441-009	K-9	1.03	2.1	1.3	<1	5.7	108
01-53441-010	K-10	0.69	1.9	1.1	1.8	12.6	95
01-53441-011	K-11	3.50	4.3	2.0	4.0	35.0	293
01-53441-012	K-12	N/A	N/A	N/A	1.3	13.9	149
DUPLICATE ANALYSIS							
01-53441-011	K-11	3.53	4.2	2.0	3.9	34.7	288
CONTROL SOIL	**	2.45	3.5	7.6	3.8	7.7	187
TARGET RANGE	**	(2.0-3.8)	(2.0-3.8)	(4.5-11.8)	(2.0-5.5)	(2.4-11.5)	(104-214)
DATE ANALYZED	**	05/11/01	5/11,14/01	05/09/01	05/09/01	05/11/01	05/11/01
BLANK	**	<0.02	<2	<1	<1	<1	<10
SPIKE, %	**	N/A	N/A	84	104	107	115
DET. LIMIT	**	0.02	2	1	1	1	10
METHOD #	**	ASA Mono #9 Method 29-3.5.2	LOI @ 400C	ASA Mono #9 Method 33-7.3.3	ASA Mono #9 Method 33-8.1	ASA Mono #9 Method 24-5.4	ASA Mono #9 Method 13-3.5